# White paper on connected health

Spreading Digital Innovation in Healthcare

NOKIA

# Contents

This White Paper was written by the **Nokia Health Division** (http://www.Nokia.com/), which relied on the medical expertise of:

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## Dr. Nicolas Postel-Vinay

Nicolas Postel-Vinay, a doctor at the Georges Pompidou European Hospital, was head of the communication office of the French Public Health Department. He also served as chair of biomedical innovation at the Collège de France for 18 months. Dr. Postel-Vinay is in charge of telemedicine and therapeutic education programs for public and private hospitals. He is one of the founders of automesure.com.

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Guillaume Bobrie (Georges Pompidou European Hospital), a nephrologist and hypertension specialist, contributed to the French hypertension and chronic renal failure guidelines. He co-founded the French Nephrology Epidemiology and Information Network, recently taken over by the Biomedicine Agency (DIADEM). He has over 20 years of experience in teletransmission and telemonitoring of patients. Dr. Bobrie has received several grants for research protocols. In particular, he has demonstrated the benefits of home monitoring of blood pressure over clinical measurement. This study of international impact was published in JAMA in 2004. Dr. Bobrie is one of the founders of automesure.com.

# Introduction

# Introduction

In less than two decades, Internet and mobile phones have revolutionized our communication methods. The health sector has eagerly embraced these new technologies. Over 11,000 professional medical journals have been made accessible online through Pubmed, the US National Library of Medicine database. Computerized exchange of medical data has facilitated telemedicine exchange protocols, and mobile phones have increased access to medical information among the general public. Over 100,000 smartphone health apps have been released. Today, medical use of new technologies has become a fully-fledged field of scientific research. Engineers, bio-statisticians and clinicians are working together to develop new forms of telemedicine that serve patients and health professionals.

Connected devices are the latest innovation in this ongoing revolution. The increasing miniaturization of sensors and the spread of smartphones have spurred the growth of new tools, which make it easier for people to monitor their health data on the go and share it with medical professionals if they so choose. Connected scales, pedometers and blood pressure monitors have never been so easily accessible. This allows the growing automation of the collection of physical or biological constants and parameters, such as weight, blood pressure, activity level, heart rate, oxygen saturation, body temperature, blood glucose level, expiratory rate, and movement and sleep indicators.

**The expression “connected health”, or “m-health” (mobile health), has come into widespread use to designate a breakthrough that is not just technological, but also social.** Until recently, only healthcare professionals monitored patients; now, patients have the tools to take many of their healthcare needs into their own hands.

The number of mobile applications is on the rise, from coaching to prevention, screening, diagnosis, monitoring, therapeutic education, adaptation of care and orientation toward treatments. For medical practice, the relevance of data gathering varies widely depending on the user profile and on the context. For example, weight data means something different based on whether it involves a child, an overweight adult or a patient with heart failure. In addition to medical diagnosis, automated data collection has socio-professional repercussions, opens up fresh prospects and raises new questions:

- **How does it impact medical practice?**
- **Does it improve users' health?**
- **Should the healthcare system be adapted to take its development into account?**

In a classic organization, patients make appointments with doctors if symptoms appear and follow their advice until the problem disappears. The proper treatment of chronic diseases reverses this relation. Asthma or diabetes patients, for example, are asked to adopt prevention behaviors. They must not only anticipate complications, but also take action if these occur. They must learn how to assess their own situation in order to decide whether or not to call a doctor. Patient empowerment requires a well-supervised therapeutic education. M-health offers new possibilities to perfect home monitoring methods and self-management programs.

**Connected health has emerged at a time when it is becoming essential given the demographic aging and soaring rates of chronic diseases.** The medical profession should not be apprehensive about healthcare consumers equipping themselves with connected devices. On the contrary, a constructive dialogue between both parties should be established. For that, a thorough assessment of the impact of these new tools and practices must be encouraged.

**Part I.**

# Connected devices: a revolution in self-measurement

# 1. Self-measurement: a practice of well-established medical benefits

Self-measurement, a long established practice, is defined as the measurement of health parameters by the patient. In the early 20th century, households started acquiring scales and thermometers, in particular because the scourge of tuberculosis required tracking changes in weight and temperature. Home monitoring of chronic diseases took off in the 1980s, when patients were given devices to easily measure their blood glucose level (first with urine strips to check for glycosuria or acetonuria, then with devices to monitor capillary glucose levels), breathing ability (with peak-flow meters) and blood pressure (with electronic blood pressure monitors).

Many studies have shown that these devices are useful in quantifying medical conditions. For example, difficulty in breathing can be accurately evaluated with a spirometer. The increase in the number of home blood pressure measurements has improved the accuracy of the definition of pressure levels, compared to measurements made exclusively in a medical environment. These devices have also proven their usefulness in the regular monitoring of chronic diseases. Data from epidemiological studies and therapeutic trials have demonstrated statistical relations between the measurements' results and the occurrence of health events. It has therefore been possible to set threshold values of these self-measured parameters above which a health risk becomes significant and, consequently, calls for medical intervention.

That is why, in current medical practice, doctors ask their patients with diabetes, asthma or hypertension to keep diaries of their home monitoring results. Recording

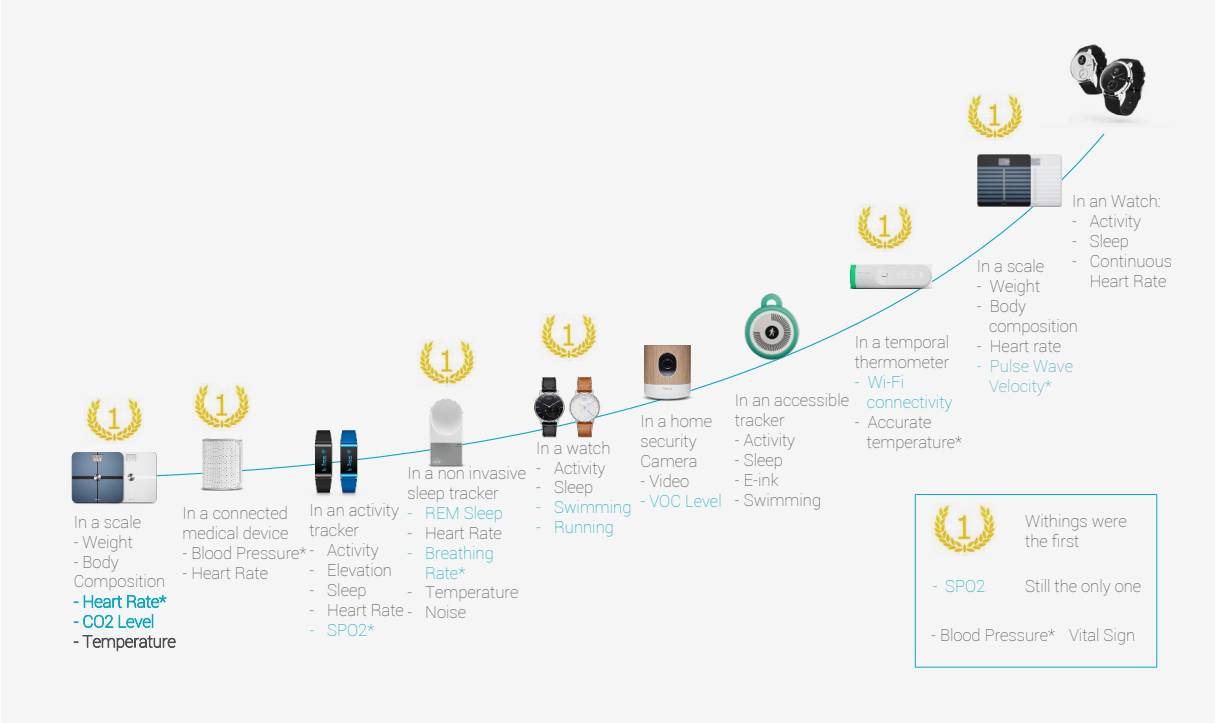
these values enables them to propose prevention plans. **The concept of self-measurement leads to that of self-monitoring and, finally, to that of self-management.** Approaches that give the patient more room to take decisions already have a strong scientific rationale. Digitalization opens the door for smart tools now able to derive preventative actions from the interpretation of this data.

## Table: Main home monitoring devices and their uses

| Parameter | Device | Pathology | Description |
|---|---|---|---|
| **Capillary glycemia** | Glucometer | Type I (insulin- dependent) and type II (non-insulin dependent) diabetes | In use since the 1980s. Recommended today by scientific associations and patient organizations, under the condition of users following a therapeutic education comprising the definition of an action plan. Effectiveness is higher for type I diabetes. |
| **Weight** | Scale | - Overweight and obesity<br>- Eating disorders (bulimia/anorexia)<br>- Diabetes<br>- Hypertension<br>- Heart failure<br>- Renal failure<br>- Pediatric disorders | Home weight monitoring dates back to the early 20th century. Measurement protocols and interpretation of results clearly differ from one pathology to another. The relation between weight and height allows the calculation of the body mass index (BMI). The scale is the most widespread self-measuring device. |
| **Blood pressure** | Electronic blood pressure monitor | - Hypertension | In use since the 1980s. Recommended since the 2000s, subject to compliance with a measurement protocol. Home measurement, considered more accurate than measurement in clinical setting, is indicated for screening and monitoring. |
| **Heart rate** | - Watch<br>- Electronic oscillometric blood pressure monitor<br>- Heart rate monitor | - Disorders related to a sports (as a leisure activity or physical therapy)<br>- Heart rate disorders<br>- Heart failure | Heart rate is monitored in certain physical activities (jogging, cycling, etc.) and cardio-vascular situations (disorder symptoms, myocardial infarction, taking of medication, etc.), but home measurement is not a common large-scale practice. |
| **Expiratory rate** | Peak-flow meter | Asthma | In use since the 1980s. Recommended since the 2000s, subject to user education as this self-measurement has a complex procedure. |

| Parameter | Device | Pathology | Description |
|---|---|---|---|
| **SpO2 (oxygen saturation rate)** | Pulse oximeter (or saturation monitor) | Chronic obstructive pulmonary disease (COPD) | Saturation meters are available for the general public but the interpretation of the results is difficult. Studies on the usefulness of home monitoring of PaO2 as a means of preventing COPD from getting worse have not yet found positive results. |
| **Number of steps & movement level** | - Pedometer<br>- Accelero-meter | - Public health campaigns against sedentary lifestyles<br>- Incitation to walk more for people with diabetes, asthma, obesity, lower limb arthritis and heart conditions | Although pedometers are inexpensive and easy to use, they are still infrequently recommended or used in current medical practice. By helping increase physical activity, they help improve the level of glycated hemoglobin, weight and cholesterol. The long-term persistence of their impact is unknown. |
| **Body temperature** | Thermo-meter | Diagnosis of fever, especially in children | The thermometer has been in very widespread home use since the early 20th century. Used to monitor infectious diseases and to guide people whether or not to call a doctor. |

## Our ecosystem of connected devices cover the essential vital signs



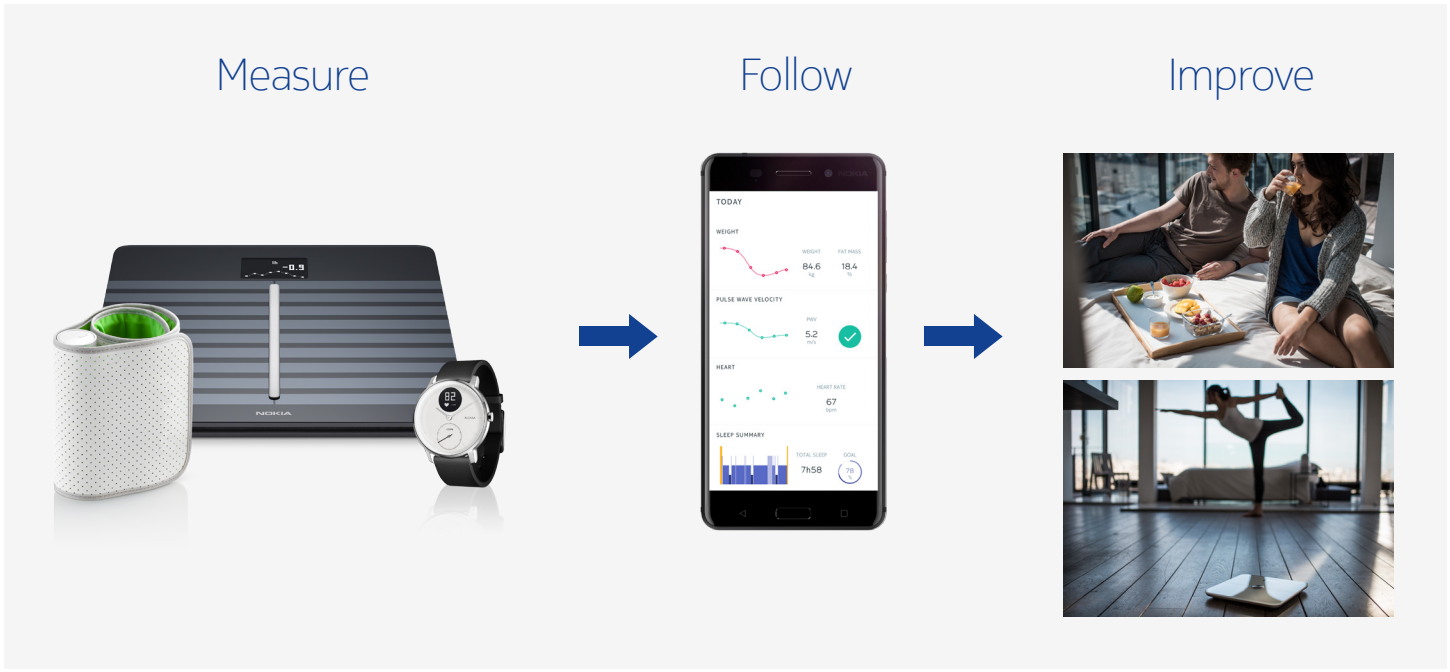
**Home monitoring and diabetes**

Home monitoring of patients with diabetes has demonstrated its capacity to significantly reduce glycated hemoglobin levels. A meta-analysis of 7 randomized studies of patients with type II diabetes comparing usual treatments to treatments using technologies allowing the tele-transmission of glucose levels has shown an average decrease of glycated hemoglobin of 0.5% [(1)]. Mobile phone coaching reduced glycated hemoglobin by 1.2% after 12 months [(2)]. According to a UKPDS study, lowering the glycated hemoglobin level by 1% helps cut the risk of all-cause mortality by 14%, the risk of myocardial infarction by 14% and the risk of microvascular complications by 37%. In addition to transmitting biological data, mobile solutions can include guidelines-compliant educational programs. Experiments on the prospect of direct connection to medical files are in progress.

# 2. Connected devices: a technological and democratic disruption

## A simplified measurement

For the first time, individuals using smartphone or tablets as communication gateways are able to compile self-measured records into an easily accessible personal dashboard, allowing them to monitor their health indicators on a day-to-day basis. For example, Nokia' Smart Body Analyzer instantly recognizes the person in the household stepping on the scale, measures its weight, fat mass and heart rate, and calculates its body mass index (BMI). All the records are sent to his smartphone over WiFi, without any additional effort. For Nokia, this simplicity of usage is the condition for a long-term monitoring that will motivate users to make sustainable progress – by managing their weight, watching their blood pressure and becoming more active.



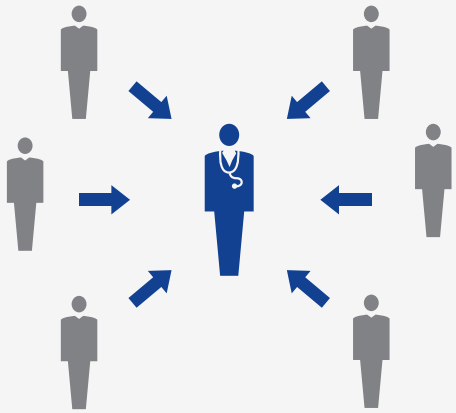

## New data, new relationship to your health

Connected devices generate new knowledge for users. In the past, weight was the only indicator that was widely monitored on a regular basis. **However as the use of connected devices becomes increasingly popular, the variety of measurements accessible to the general public is on constant rise.** Dr. Eric Topol, an American cardiologist author of the book "The Creative Destruction of Medicine", draws a list of pathologies [3] that users can learn to better manage using connected devices:

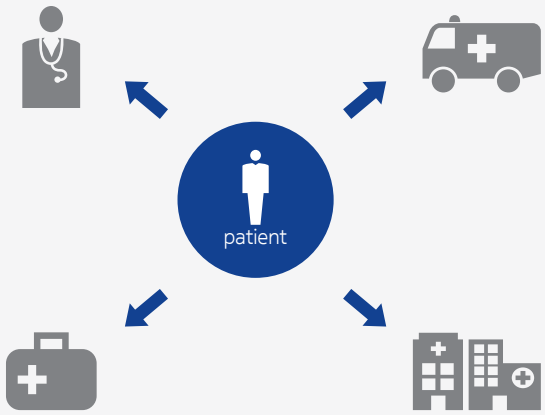
- **Obesity and nutrition disorders:** the monitoring of weight, activity level, quantity of ingested and burned calories is one of the main m-health applications;
- **Hypertension:** treated better thanks to the dissemination of connected blood pressure monitors, which help increasing observance and avoiding the "white coat" effect;
- **Diabetes:** connected glucometers allow monitoring glycemia and the hemoglobin level in the blood, for the purpose of adjusting treatments;

- **Sleep disorders:** new monitoring devices, worn on the wrist or placed on the bed, enable patients to learn more about the phases of their sleep;
- **Chronic obstructive pulmonary disease (COPD):** activity trackers and connected oximeters can improve COPD treatment;
- **Asthma:** treated better by monitoring the respiratory rate; the detection of peak flows can prompt patients to use an inhaler before the onset of a new attack.

This technological breakthrough modifies the relation to one's health. **Individual are empowered. They are not just involved in monitoring and controlling their health indicators. They are also sharing this information with communities of patients and with their doctors.** On the doctors' side, it is becoming increasingly harder to ignore patient-generated data. Doctors will have to learn how to use this new source of information to enrich and improve their diagnoses.



From **passive and limited data collection…**




… to active, continuous **patient-centric monitoring** & **Holistic Health Care Data Storage**

**Part II.**

# Better manage one's health, rethink medical practice

# 1. Tools that reinvent prevention

With Internet-connected devices, users are reinventing the relationship to their health. In this new paradigm, health no longer refers uniquely to patients' relationship to their diseases. There is an increasing interest in healthy individuals, not with the purpose of treating or curing them but of helping them to reach an optimal management of their health state, based on its continuous evaluation.
In 2014, Nokia conducted a study on the impact of connected devices on health. The study was unprecedented because no one had ever analyzed representative sample data of scale, blood pressure monitor and activity tracker users. The findings outline the positive effects of the usage of these connected devices on weight and blood pressure control, and on the stimulation of physical activity.

## Weight control

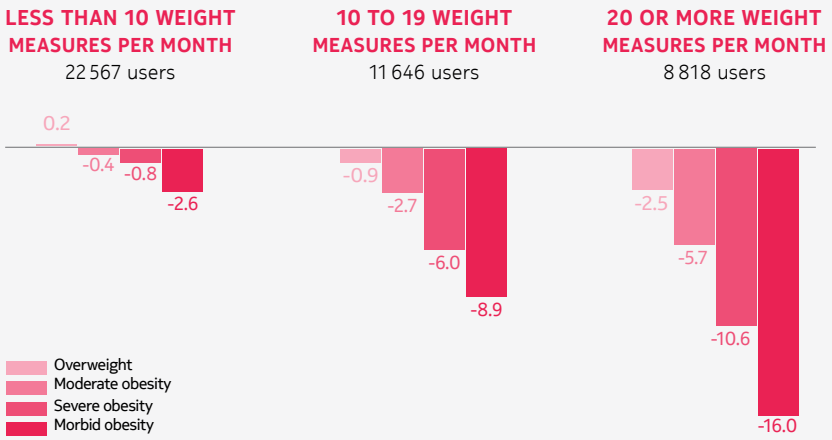
**Obese users who weigh themselves on a regular basis lose in average much more weight than those who do not.** For example, users with very severe obesity who used their scales 20 or more times in one month lost six times more weight than those who used their scales less than 10 times over the same period.

The study showed that **setting weight targets on the mobile app – with automatic reminders – is correlated to weight loss.** On average, users with very severe obesity who set a target lost 3.12 kg, two times more than those not having set a target (1.56 kg).

## Average weight evolution according to the frequency of weight measures

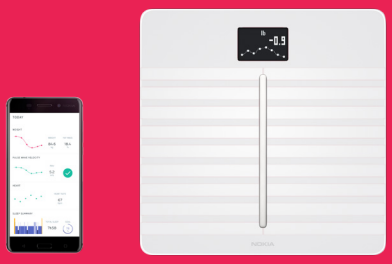
in lb, over a 12-month period

**Sample of overweight or obese users 20 to 79 years old, having used both the scale and the BP monitor in the 12-month period May 13 to April 14.** Weight evolution computed as the difference between 12th and 1st month averages; weight measure frequency as the average number of measures per month over the months of utilization of the scale in the period; BMI class according to WHO classification and as the average at the 1st month of utilization of the scale in the period. $p < 0{,}001$.

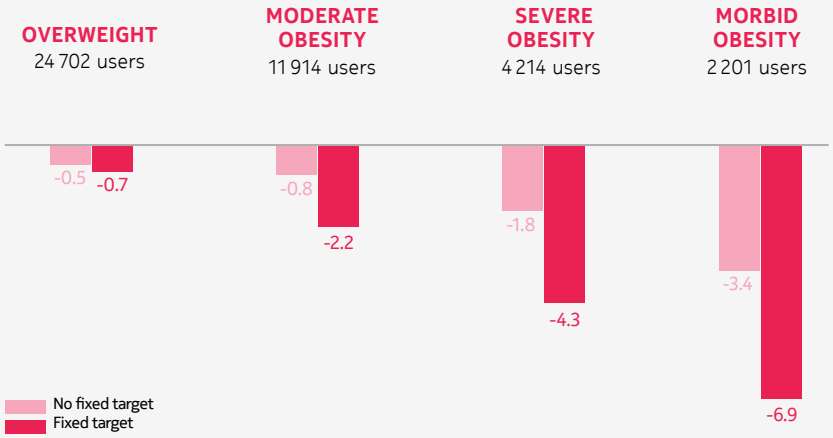



## Average weight evolution according to the existence or not of a fixed weight target

in lb, over a 12-month period

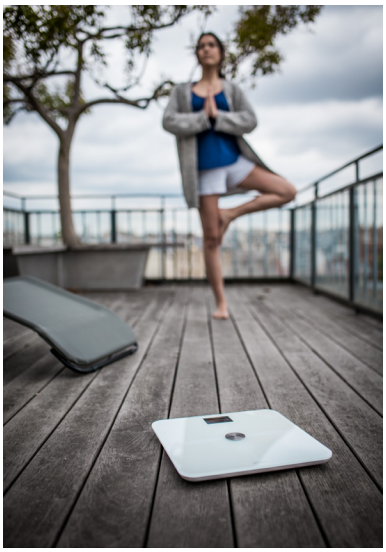


**Sample of overweight or obese users 20 to 79 years old, having used both the scale and the BP monitor in the 12-month period May 13 to April 14.** Weight evolution computed as the difference between 12th and 1st month averages; BMI class according to WHO classification and the average at the 1st month of utilization of the scale in the period. $p < 0{,}001$.




**The scientific literature reveals similar findings.** For example, a study published in "JAMA" [4] analyzed 69 overweight or obese people above 50 years old who were under a diet. The group was divided into two subgroups, one with mobile coaching and the other without. The study showed that after six months, the group coached by mobile phone lost an average of 3.9 kg more than the group following standard treatment, and 41% of the mobile group reached the goal of losing at least 5% of their weight, vs. 11% for the others.

**“With Internet-connected devices, users are reinventing the relationship to their health.”**



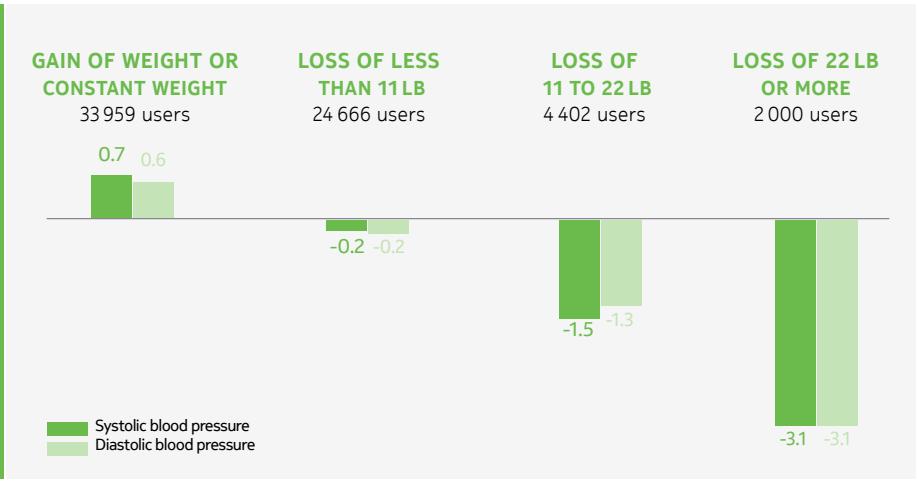
## Blood pressure control

A **high correlation between weight loss and blood pressure reduction** has been observed. Users in the Nokia study who lost 10 kg or more over the period of a year also lowered their systolic and diastolic pressure by 3 mmHg.

### Average blood pressure evolution according to average weight evolution

in mmHg, over a 12-month period

**Sample of users 20 to 79 years old, having used both the scale and the BP monitor in the 12-month period May 13 to April 14.** Weight and blood pressure evolution computed as the difference between 12th and 1st month averages. No information about the consumption of hypertension drugs by the users. $p < 0{,}001$.



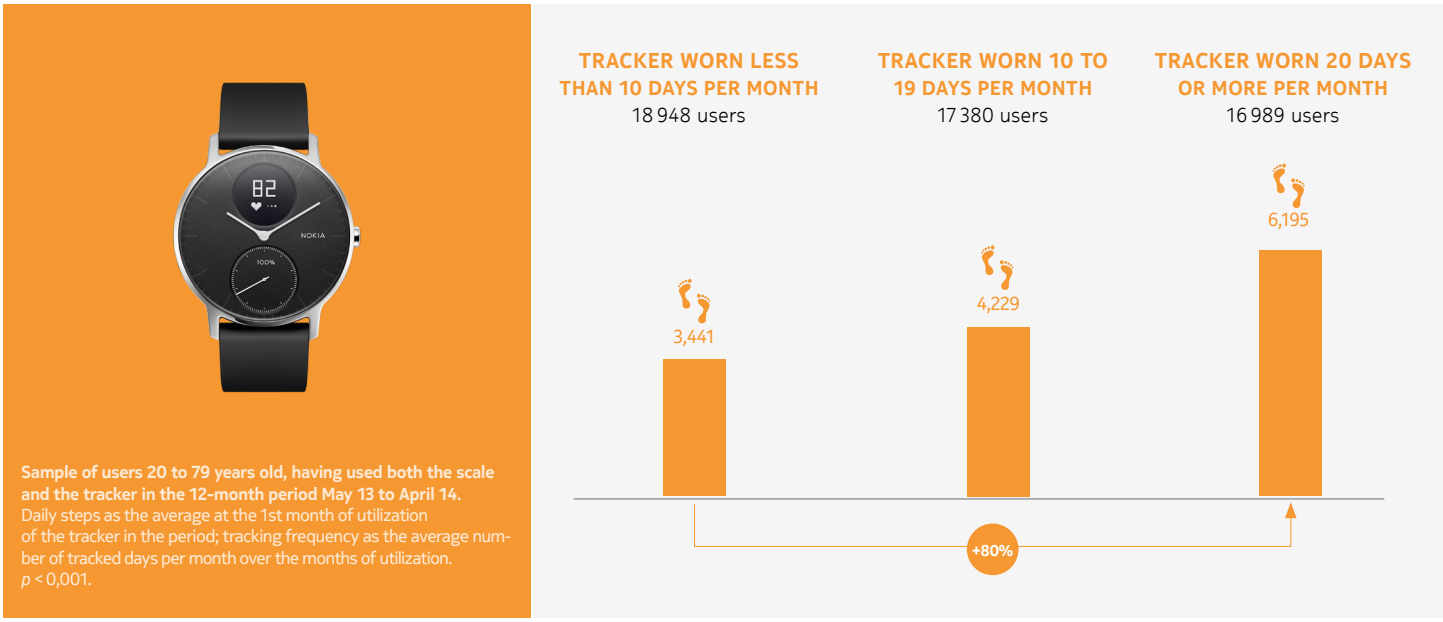

Likewise, a study by the Center for Connected Health on the use of connected blood pressure monitors, published in May 2013 in the "Journal of Diabetes Science and Technology" [(5)], concludes that **wireless monitoring has a positive impact on users' adherence, on clinical results and on the operational efficiency of telemedicine.** Participants in a wireless-connected blood pressure monitoring program take their blood pressure more often and transmit more data than those who connect by modem (0.46 compared to 0.01 data transmissions per day, respectively). The conclusions are also positive for the control of blood pressure levels: the connected blood pressure monitoring program had the effect of reducing the participants' systolic pressure by 6 mmHg and diastolic pressure by 2 mmHg. According to the study, a decrease of 5mmHg reduces the heart attack mortality rate by 14% and the heart disease mortality rate by 9%.

## Stimulation of physical activity

Last, the study conducted by Nokia examined data from activity trackers. One of the main conclusions of the study is that **the regular use of the connected tracker is correlated to a higher level of physical activity.** Users who wore the tracker 20 or more days during the first month of use walked an average of 6,195 steps a day, 80% more than the average of 3,441 daily steps recorded for users who wore it less than 10 days a month.

**Average number of daily steps according to the frequency of utilization of the tracker**

in number of steps per day



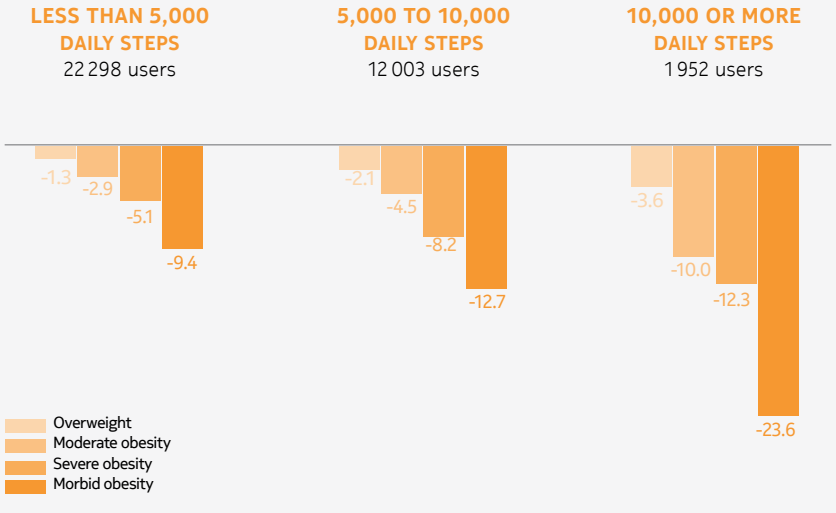

**Sample of users 20 to 79 years old, having used both the scale and the tracker in the 12-month period May 13 to April 14.**
Daily steps as the average at the 1st month of utilization of the tracker in the period; tracking frequency as the average number of tracked days per month over the months of utilization.
$p < 0{,}001$.

These figures confirm the findings of scientific studies such as the one published in 2007 in "JAMA" on the impact of pedometers [(6)]. The study showed that **people who monitor themselves with a pedometer walk an average of 2,000 additional steps a day, and record a drop in their blood pressure of 3.8 mmHg.** Similarly, the Nokia study shows that **the most active users are also the ones that lost more weight.**

## Average weight evolution according to the number of daily steps and BMI Class

in lb, over a 12-month period


**Sample of overweight or obese users 20 to 79 years old, having used both the scale and the tracker in the 12-month period May 13 to April 14.** Weight evolution computed as the difference between 12th and 1st month averages; daily steps as the average at the 1st month of utilization of the tracker in the period, BMI class according to WHO classification and as the average at the 1st month of utilization of the scale in the period. $p < 0{,}001$.



## Connected devices as a promoter of physical activity

Exercise improves many dangerous metabolic, cardiovascular and respiratory conditions and has consequently a favorable impact on mortality. However, in a society where the life style becomes increasingly sedentary, physicians struggle to convince their patients to exercise more. Connected devices combine motivational programs with objective measurement of activity level.

- **Pedometers count the number of steps** in a given period of time by recording up-and-down movements. Even if a person's physical activity is not limited to walking, it constitutes a useful tool for estimating the total amount of daily movements.
- **Accelerometers record the accelerations and decelerations** caused by the user's movements, in one or more planes. Acceleration of body mass and limbs being proportional to energy expenditure, accelerometers are also used to estimate the calories burnt during physical activity, based on pre-established equations integrating the user's characteristics, in particular his weight. The device must be worn for several days in order to estimate the user's usual level of physical activity.
- **GPS (global positioning systems) are used to evaluate the location** of a physical activity in order to put it into context and study the environment's influence.

**“The regular use of the connected tracker is correlated to a higher level of physical activity.”**

# 2. A paradigm shift in medicine

For healthcare professionals, mobile phones, Internet and connected devices have a major impact. Mobile phones have already revolutionized the access to emergency care, and the Internet has proven its usefulness in terms of health-related patients' education and information. Today, **connected devices reinforce physicians' adherence to long-term monitoring and limit therapeutic inertia regarding chronic diseases. Most importantly, they foster a new relationship between the patient and the doctor,** who will have to take into account this new source of information.

## An effect on compliance and therapeutic inertia

It is already known that sending automatic SMS reminders raises the odds that patients will take their medication when they should. Several studies with established methodologies have demonstrated its positive impact regarding malaria treatment [(7)], anticoagulant therapy after myocardial infarction [(8)], and diabetes medication [(9)]. The most positive impact was recorded in the assistance to smoking cessation. Similarly, combining coaching through SMS with relaxation programs available on the Internet has shown to be effective [(10)]. There are already many Internet programs aiming to help people lose weight and to encourage them to exercise.

**Text messaging can help to prevent and manage chronic diseases**

Sending automated SMS to help monitor chronic diseases has already proven its usefulness in various scenarios. Experiments have shown positive results, especially in helping people quit smoking or lose weight. For example, experiments have allowed patients with type II diabetes to better control their glycated hemoglobin levels, and to better follow a drug treatment (anti-malarial and diabetes medication, and anticoagulant therapy after a myocardial infarction). There is no lack of interesting studies but those with rigorous methodology are not numerous (4 randomized studies including 182 participants according to a 2012 Cochrane review), and there are negative experiments. Medical use of SMS also involves prevention, for example in monitoring pregnancy or the intake of vitamin C. Although there is a gap between a sometimes too-enthusiastic communication and the availability of proofs, medical use of SMS constitutes an element in favor of the development of the m-health.

M-health encourages patients' adherence and limits doctors' therapeutic inertia. Follow-up studies of hypertension patients treated by telemedicine show for example how teletransmission of blood pressure levels not only boosts patients' adherence, but also influences doctors to adapt treatments more actively.

**Impact of blood pressure home monitoring on therapeutic inertia**

A randomized telemonitoring study [11] involving 401 patients has shown that combining home monitoring of blood pressure with telemonitoring of the results by nurses helps control hypertension better. The best result (4.3 mmHg for systolic and 2.3 mmHg for diastolic pressure) is obtained when doctors telemonitor their patients. Teletransmission led them to increase treatments more often than for the group with traditional care. However, this advantage is offset by a higher cost of care.

Likewise, a smartphone app has proven its ability to influence the behavior of patients being treated for alcoholism. An alert warns users when they come near a usual place of alcohol consumption, whose location has been recorded beforehand. Another interesting example concerns connected bracelets used for GPS monitoring of patients with Alzheimer's disease, which have the effect of delaying their admission to specialized residences. These devices are today commonplace.

**Geolocation combined with support programs to assist patients being treated for alcoholism**

Smartphones can combine various functions such as access to multimedia information, geolocation, and SMS. All of them have been brought together in an app to support patients undergoing treatment for alcoholism. In a randomized clinical trial [12], patients who were trying to stop drinking were connected, with sharing of geolocation data. All the usual places where they went drinking were recorded in the app beforehand. When they approached one of these places, the app automatically sent a message asking the user if he or she "really wanted to be there". The app also offered relaxation programs and allowed the user to contact a support person. A scientific evaluation demonstrated the app's effectiveness.

**“Connected devices reinforce physicians’ adherence to long-term monitoring and limit therapeutic inertia regarding chronic diseases.”**

## A new doctor-patient relationship

**Broader access to medical information is changing the doctor-patient relationship.** To mention just one figure, in France, nearly 25% of connected blood pressure monitor users over 60 years old communicate their data to their doctors. This figure reaches 42% in the United States and 31% in Germany. Sharing information has become a common practice.

### For the improvement of the patient-doctor relationship

Tools that allow to easily exchange data

**42%**

of American Wireless Blood Pressure Monitor users over 60 **share their data with their doctor.**

**Source:** Survey conducted on 1172 senior users in December 2013.


By making home telemonitoring simpler, these new technologies have led to rethinking the patient and doctor relationship, which now goes beyond the medical consultation. **The technological change is therefore also a signifier of sociological change, as it becomes easier to know what happens to patients between consultations.** This paradigm shift is particularly noticeable in the case of chronic disease.

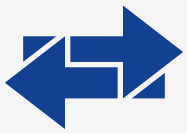
## Nokia smart objects enable the doctor-patient relationship

For better prevention

**Doctor**

**Data sharing**

**Disease management**



**Patient**

### Nokia Activity Tracker

- Motivates patients to stay active.
- Combats the effect of metabolic syndrome.
- Monitors resting heart rate.

### Wireless Blood Pressure Monitor

- Easy and precise self-measurement.
- Helps patients maintain healthy blood pressure levels between consultations.
- Helps adjust dosing requirements based on circadian rhythm patterns.

### Smart Body Analyzer

- Effortless weight, body mass and heart rate monitoring.
- Motivates patients to lose and maintain a healthy weight.
- Helps congestive heart failure patients monitor their fluid status.

## Did you know?

- The University Hospital of Toulouse uses Nokia devices to help adjust the treatment of type 2 diabetes patients (Project Educ@dom). → http://economie-numerique.blogspot.fr/2013/11/congres-antel-educdom.html
- UCSF's groundbreaking Health eHeart study uses Nokia devices. → http://www.health-eheartstudy.org
- Activity trackers tend to motivate users to walk an extra 2,000 steps a days on average (Source: "Using Pedometers to increase Physical Activity and improve Health", JAMA. 2007; 298 (19): 2296-2304). → http://jama.jamanetwork.com/article.aspx?articleid=209526



**New telemonitoring possibilities are not only changing telemedicine in its existing framework; they are also contributing to its generalization.** The popularization of

connected devices reduces the cost of telemonitoring chronic conditions (diabetes, heart failure, hypertension, etc.), as each patient is able to use these technologies with his or her smartphone, and to send the resulting data directly to his or her doctor. In addition to economic gains, telemedicine can improve the comfort and quality of life of patients suffering from a chronic disease. It can reduce travel time, shorten the length of a hospital stay, lower the number of doctor appointments and raise the patient's level of therapeutic education.

**Connected devices make it easier to know what happens to patients after they leave the hospital or between two medical consultations.** This is particularly true regarding obesity surgery, where patients are equipped with connected scales and blood pressure monitors. For heart operations, activity trackers can be used to monitor patients after the intervention. Telemonitoring using activity trackers shows also to be useful in cases of hip replacement surgery, to facilitate physical reeducation and to allow when needed for an intervention in time to avoid a re-hospitalization. This benefits the patient and also helps cutting healthcare costs.

**With connected devices, doctors have therefore access to new information generated by the patients themselves, which can be used to improve the control of patients' health conditions outside consultations.**

## Examples of telemonitoring uses of connected devices

### Measures

**Weight, BMI & Body Fat Percentage**

**Blood Pressure** (diastolic and systolic) and **Heart Rate**

**Activity**
(steps, elevation, calories)

**Sleep phases**
(light, deep, awaken)

### User Data

Age

Gender

Family situation

Living area

Medical condition

Fréquency of measures

### Applications

- Heart failure tracking
- Diabetes prevention and pre-diabetes management
- Hypertension diagnosis
- Assessment of diuretics' effectiveness
- Cardiovascular risk detection
- Respiratory diseases tracking
- Management of post-bariatric surgery conditions
- Sleep disorders tracking
- Sleep apnea detection

# 3. The need to reform the healthcare circuit

## A new distribution of tasks

M-health leads to a greater delegation of doctors' tasks, in particular in the monitoring of drug therapies and of hygiene and dietary treatments. Tasks tend to be delegated to the patient, but also other health professionals – nurses, pharmacists, telemedicine assistants, etc. As an example, studies showing the benefits of connected glucometers use nurses for the adaptation of insulin doses given to patients with type I diabetes. Overall, the healthcare circuit is influenced by the interpretation of connected devices results: an abnormal result will prompt users to make an appointment with a doctor, while a reassuring one will encourage them to postpone their appointments and maintain their successful regimen.

## A new momentum for telemedicine

The integration of connected devices to telemedicine practices is still in its infancy, both for prevention and monitoring of disease. More detailed medical-economic evaluations are needed, in order to establish the medical relevance and the potential for optimization of the healthcare costs of these devices. Many implementations in the United Stated and in Europe show already encouraging results.

- In the United States, Saint Vincent Health has set up a telemonitoring system in Indiana for patients with congestive heart failure and with chronic respiratory failure. After two years, initial results show that the re-hospitalization rate of patients fell to 5%, a 75% drop compared to the American average. In France and in Germany, the Cardiauvergne and Alere programs aim to perform similar studies.
- Since 2016 at Ochsner Health Systems, hypertensive patients leave the hospital with a wireless Nokia blood pressure cuff, which sends data to the care team. Results show that patients hypertension control rate have gone up to 86% compared to a 52% US average.[13]

- The Mayo Clinic, Kaiser Permanente, Duke University, Leiden Hospitals or even North Norway hospitals are now using Nokia devices now, not simply to test that remote weight monitoring can help identify cardiac decompensation, but to predict and prevent hospitalization.

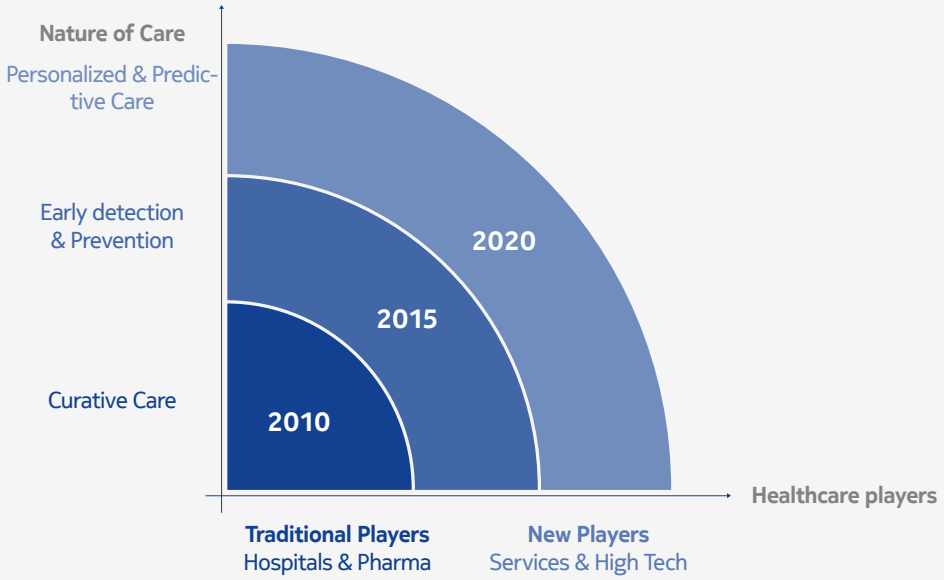
A study carried out by Myriam Le Goff, a professor and researcher at Télécom-Bretagne, in association with the consulting firm JALMA [(14)], estimates that the deployment of telemedicine for four chronic diseases (diabetes, hypertension, heart failure and kidney failure) could generate up to $2.6 billion in healthcare savings. Similarly, in 2013 PricewaterhouseCoopers assessed at €99 billion the total of healthcare savings for the European Union that could be attained by 2017 [(15)]. Four years later, connected health is finally beginning to deliver on its promise of scaling to include more patients.

## From preventive to predictive medicine, from doctors to data scientists

Connected devices do more than just produce data for users, patients and doctors as part of individual care. They also generate a collective intelligence thanks to the mass of data that can be aggregated to analyze overall trends. For Google founder and CEO Larry Page, **the use of health data for the advancement of medical research "will save hundreds of thousands of lives.**"

The mass of collected data opens the door to much more accurate analyzes of the healthcare system – with the purpose of optimizing it –, and ultimately to a shift from preventive to predictive medicine. With Big Data providing increasingly numerous tools to prevent and predict pathologies, the data scientist role emerges in the clinical space, suggesting an evolution of the medical profession.

## Expected evolution of healthcare




**Source:** *Santé : Horizon 2020*, JALMA ; Nokia

There are numerous perceptible signs of this evolution. In Great Britain, for example, the General Practice Research Database [(16)], an anonymized database of medical records created under the authority of the NHS, has already served as a basis for nearly 1,200 academic studies. These studies have for example improved clinicians' understanding of the causes of rheumatoid arthritis, and helped them to better dose anticoagulant drugs in atrial fibrillation treatments.

The following table shows some examples of how Nokia connected devices are used in medical studies in universities or hospitals.

## Table: Examples of medical use of Nokia connected devices

| Partner | Concern | Description | Device used |
|---|---|---|---|
| Cornell University | Nutrition | An intervention using Wi-Fi scales and graphic e-mail f eedback, the caloric titration method (CTM), to reduce age-related weight gain over 1 year among college students was evaluated. CTM intervention was effective in preventing age-related weight gain in young adults over 1 year and thus offers promise to reduce overweight and obesity rates. | Body Scales |
| American Medical Group Association | Hypertension | Nokia teamed up with the American Medical Group Foundation (AMGF) to work on an 18-month project seeking to improve blood pressure control in patients with uncontrolled hypertension, in conjunction with the national Measure Up/Pressure Down® hypertension campaign | Blood Pressure Monitors |
| Inserm-Université Pierre et Marie Curie | Activity & Hypertension | A study was built upon cross-sectional and longitudinal data from a pool of 19,000 adult owners of Nokia activity trackers and wireless blood pressure monitors. The aim of the study was to assess the link between physical activity levels and blood pressure. The study gave way to an abstract at the European Society of Hypertension. | Data |
| Tampere University of Technology | Weight Management, Behavioral Science | The aim is to study randomized data sets of longitudinal weight data to determine how variations in weight are related to successful weight management and to develop coaching algorithms that would prove more efficient in self-guided behavioral change. | Data |
| Mayo Clinic | Chronic Heart Failure | Mayo Clinic uses remote monitoring for patients with Chronic Heart Failure with the help of the Nokia activity tracker, Body Scale and Nokia Blood Pressure Monitor to decrease the number of readmission rates | Blood Pressure Monitors, Body Scales & Nokia activity tracker |
| Stanford University | Bariatric Surgery | The aim of the study is to assess the impact of a connected scale and an activity tracker on patients undergoing bariatric surgery. All patients undergoing bariatric surgery will be recruited preoperatively. They will be provided a recommended exercise regimen and also some general wellness information via the Health Mate application. Also, they will receive bi-monthly phone calls to monitor and encourage their progress | Nokia activity tracker & Body Scales |

| Partner | Concern | Description | Device used |
|---|---|---|---|
| Scripps Transiational Science Institute | Diabetes, Hypertension, Heart Arrhythmia | In the context of the "Wired for Health" study, 200 participants with common chronic diseases –diabetes, hypertension or heart arrhythmia– have been given a Nokia blood pressure monitor and a Nokia Body Scale. Results will be compared to those of a control group. | Blood Pressure Monitors, Body Scales |
| Scripps Transiational Science Institute | Hypertension | Recent work has suggested that variability in blood pressure readings may be a more appropriate measure of cardiovascular risk. The objective of the study would be to explore and describe intra-individual variability (20000 users in the US), how that differs between individuals, and what characteristics, if any, are related to this variability such as age, gender, time of day, work day or weekend and season. | Blood Pressure Monitors, Body Scales |
| University Hospital of North Norway & Norwegian Centre for integrated Care and Telemedecine | Chronic Heart Failure | The Norwegian Center for integrated Care and Telemedecine, in partnership with the Northern Norway Hospital, is equipping a number of cohorts of patients suffering from heart failure with Nokia connected Body scales, with the objective of generating automatic alerts for these patients. | Blood Pressure Monitors, Body Scales |
| Société Européenne d'Hypertension | Blood Pressure Measure Validation | The aim of the present study was to validate the Nokia automatic oscillometric blood pressure device according to the European Society of Hypertension international Protocol. This study showed that the accuracy of the Nokia oscillometric device fulfills the international Protocol requirements. | Blood Pressure Monitors |
| University of South Australia | Activity Measurement | In free-living conditions, the consumer-level activity monitors showed strong validity for the measurement of steps and sleep duration, and moderate validity for measurement of vigorous physical activity, sleep and total daily energy expenditure. | Nokia activity tracker |
| University of Pennsylvania | Hypertension | The University of Pennsylvania is conducting a study that will examine if social incentives improve adherence to home blood pressure monitoring in patients with hypertension. | Blood Pressure Monitors |

| Partner | Concern | Description | Device used |
|---|---|---|---|
| Centre Hospitalier Universitaire (CHU) d'Anger | Spine Surgery | The aim of the study is to assess the relevance of activity trackers for post-surgery monitoring of patients having had neuro-spine surgery to remove tumors. Trackers will serve to assess the quality of life in two different groups of patients with two different surgeries with an activity tracker. | Nokia activity tracker |
| Centre Hospitalier Universitaire (CHU) de Saint-Étienne | Artheriopathic Disease | 50 patients with artheriopathic disease will be equiped with a Nokia activity tracker to assess physical activity. The aim is to investigate the impact of walk training on these patients. | Nokia activity tracker |
| French Union of Cardiologists | Hypertension | The study investigates the impact of the use of connected devices: the Nokia activity tracker, the Nokia Blood Pressure Monitor and Health Mate mobile application with hygieno-dietetic messages on the management of high blood pressure among 50 patients. | Nokia activity trackers, Blood Pressure Monitors |
| HEGP Nephrology | Nephrology | The aim of the study is to investigate the impact of physical activity on cardiovascular risk among 60 patients from European Hospital Georges Pompidou with kidney transplant since 2 years. | Nokia activity trackers |
| HEGP Cardiology - Hy-Result | Hypertension | Hy-Result is the fist software for self-interpretation of home blood pressure measurement results, taking into account both the recommended thresholds for normal values and patient characteristics. We compare the software-generated classification with the physician's evaluation. Classification by Hy-Result is at least as accurate as that of a specialist in current practice. | Health Mate |
| University of Manchester | Weight Loss | Manchester University and Nokia collaborated on a first of kind scientific aimed at understanding how weight change signals from connected device users can be harnessed to understand weight management in populations. | Body Scales |
| Stanford University | Pediatric Cardiology | Prof. David Michael Axelrod uses "Baby Body scales" at Stanford University's hospital for his pediatric, pediatric cardiology and general cardiology studies. | Scales |

| Partner | Concern | Description | Device used |
|---|---|---|---|
| University College Dublin (UCD) | Obstetric Diabetes | Nokia blood pressure monitors, Body scales and trackers are being used in a study of pregnant women suffering from type 2 diabetes. | Blood Pressure Monitors, Body Scales |
| Centre Hospitalier Universitaire (CHU) de Toulouse | Diabetes | The Educ@Dom project aims at equipping around 100 type 2 diabetes patients with connected devices to be used at home (Body scales, blood pressure monitors and trackers). These devices would allow the generation of alerts for an early medical intervention. | Body Scales |
| UCLA | Weight Loss | Nokia Body Scale is being used in a weight loss study using 3 different control groups. One of the groups will have a scale and will be monitoring weight loss outcomes. | Body Scales |
| University of Minnesota | Weight Loss | The University of Minnesota is inviting men and women to participate in a 2-year project to test the importance of how often people weigh themselves during a free 12-month weight loss program. | Body Scales |
| Hôpital Universitaire Pitié-Salpêtrière | Public Health | In association with the French National Railway company, Nokia organized a public challenge around physical activity, which recruted 6200 members who tracked their steps for a period of 10 weeks. These same participants were asked to participate in a public health study, aimed at assessing the real impact of public transports on physical activity. | Nokia activity trackers, Activités Pop, In-app steps tracking |
| Brockton Hospital | Chronic Heart Failure | Pilot with Brockton Hospital managing patients with Chronic Heart Failure in collaboration with our partner igetbetter. Patients received a weight scale and a wireless blood pressure cuff. Data from the devices was integrated through igetbetter where the care coordinator would measure the patients vitals. The goal was to reduce readmission rates. | Blood Pressure Monitors |
| Institut Pasteur Lille | Childhood Obesity | “Ensemble Prévenons l’Obésité Des Enfants” (EPODE, Together Let’s Prevent Childhood Obesity) is a large-scale approach for communities to implement effective and sustainable strategies to prevent childhood obesity. A project conducted with the collaboration of Nokia consisted of monitoring 250 children from 8 to 11 years old, equipped with activity trackers in order to test the relevance of a new program. | Nokia activity trackers |

| Partner | Concern | Description | Device used |
|---|---|---|---|
| Quantified Self Institute (QSI) | Behavioral Science | 100 people of the LifeLines cohort (largest biobank in Europe with 165,000 participants) will be equipped with Nokia Body scales and activity trackers in order to investigate the impact and experience of these smart devices. Participants will also answer questionnaires and provide a blood sample at the end of the study. | Body Scales & Nokia activity trackers |
| University College Dublin (UCD) | Dementia | The Nokia activity tracker and Nokia Body scales were used to track activity and weight of patients with dementia on a longitudinal basis, with the help of their caregivers. The aim is to use this data in combination with information from functional assessments and other devices to simultaneously inform the physicians in primary and tertiary care of the patient's status on an ongoing basis. | Blood Pressure Monitors, Body Scales, Nokia activity trackers |
| Leiden Hospital | Heart diseases | Leiden Hospital uses Blood Pressure Monitor, Body scales, ECG from another device manufacturer with the aim to avoid "9 hospitalizations out of 10" for patients with heart problems. Devices are integrated in hospital platform that generates alerts in case a closer follow-up is necessary. | Blood Pressure Monitors, Body Scales |
| HEGP | Weight loss and blood pressure | Our purpose was to assess the impact of a decrease of body mass index (BMI) on BP by a cross-sectional and longitudinal multivariate study. Our study confirms these results using data measured in real life, using connected devices. Moreover, this study shows an objectively evaluated association between an exposure and an out-come in a longitudinal study. | Data |
| HUS | Post-Acute Stroke Pilot | Patients have a 30% chance of being hospitalized again in the next 3 months after a first stroke. To address this, Nokia partnered with the HUS department neurology department to build a remote monitoring solution to track patients vital signs continuously and prevent future accidents | ECG monitor, Blood pressure monitor |

**"At HUS, we see tremendous value in collaborating with innovative companies like Nokia to help the development of research-based knowledge into technologies that can drive more effective, personalized care for our patients", says MD, PhD Nina Forss, Head of Department of Neurology. This new collaboration reflects our continued commitment to excellence in research and improves the health and care of our patients at the later stage of the treatment chain."**

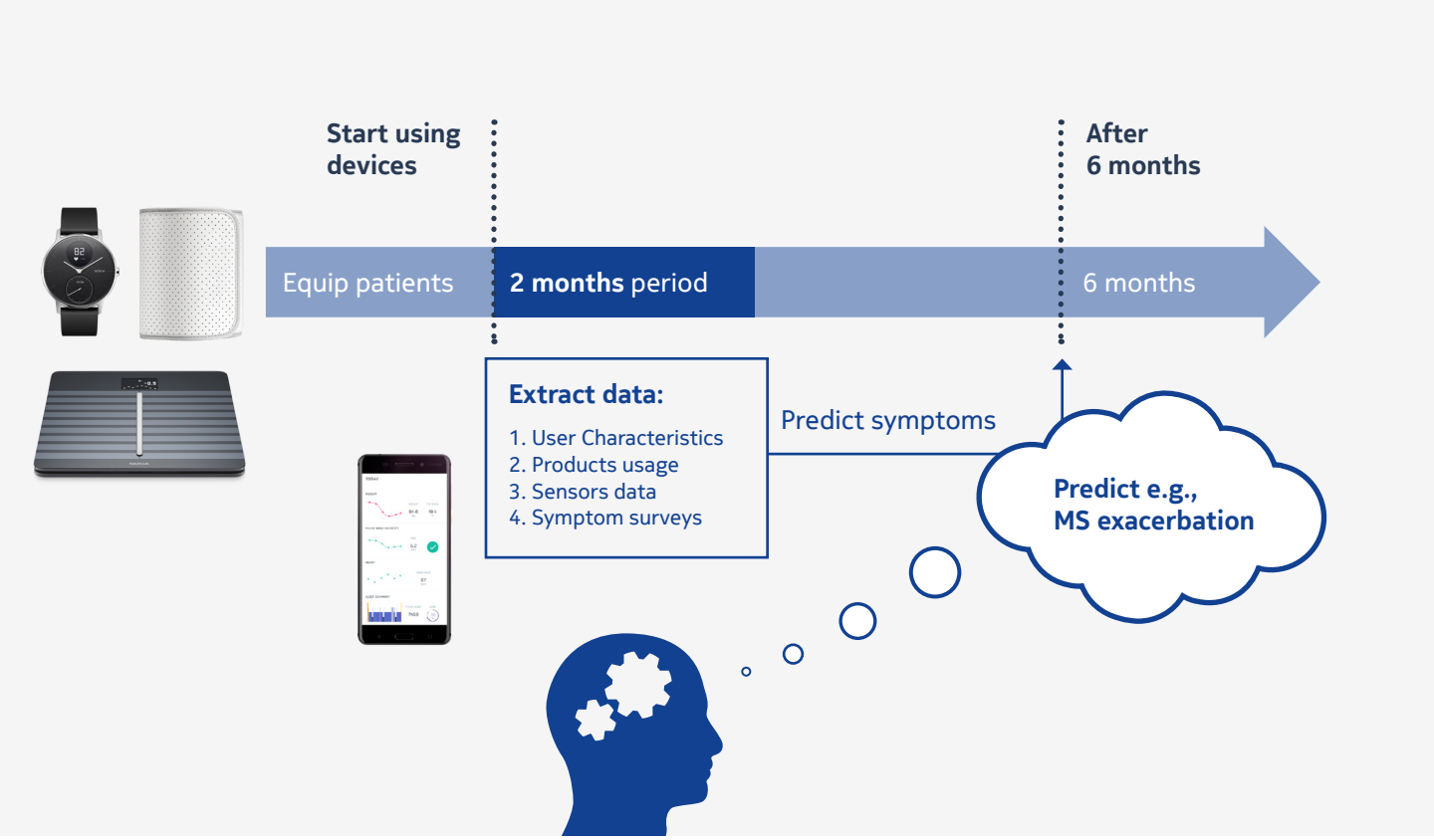
## Making sense of the data to predict undesirable health events

As Wearables have become household devices for a growing number of users, patients and doctors alike, clinicians are beginning to actually test the most exciting hypothesis of all: Can the wealth of data generated by the devices actually predict and prevent undesirable health events? We have already seen this hypothesis proven for congestive heart failure patients. Now, researchers and clinicians are discovering a new green field of game- changing applications. In short, any chronic disease with acute episodes could potentially be revolutionized by sensors, provided they are able to pick up early critical values. While humans may not be able to identify the correlations between these "weak signals" picked up by sensors, machine learning techniques may allow refinements and continuously improve the generation of health alerts. This will entail continuously diminishing "false positive" alerts and "false negatives". Research teams in the United-States and Europe are now studying how Nokia wearable devices can help detect exacerbations from patients suffering from Multiple Sceloris (MS) and Cystic Fibrosis (CF). While these two diseases are very different, both studies aim to test how patient self-monitoring using a wide array of sensors can help detect and better manage exacerbations. Studying alerts can help clinicians develop a patient's personalized educational plan, enabling better management of exacerbations, including ability to make informed choices.

Expectations for such research is high. Scientists hope to offer patients better quality of life and reduce disease related anxiety and depression. Clinical teams aim to demonstrate that the use of devices at home by educated patients fits into their daily life and effectively contributes to better care.

## Using machine learning to predict undesirable health events

Can sensors data predict appearance of symptoms in 6 months ?



**Part III.**

# Levers to speed up the deployment of m-health

# 1. Encourage adoption by doctors

## Investing in experimentation and evaluation

**An evaluation and certification effort is still necessary to convince healthcare professionals and authorities to adopt innovation more readily.** The evaluation studies should be set under a pragmatic framework, instead of being uniquely based on classic methodologies for clinical trials. Of course, the hypotheses and results tested must be relevant, the study population well characterized, and the methodology free of bias. The sample of study subjects also needs to be large enough to allow for relevant demonstrations. All these requirements come naturally with a cost. Investing in research is necessary.

The digitalization of medical and prescription records has mobilized considerable expertise in the past 30 years. The same phenomenon is seen with telemedicine, with experiments applied to disease management in the context of home monitoring. So far, these implementations have not fully succeeded to demonstrate cost-effectiveness potential. **The economic challenge of mobile health in the context of connected home monitoring will be to offer solutions that are less expensive than telemedicine practices currently employed by the medical profession.**

## Patient-generated health data flows seamless to most EHR


The integration of connected devices into existing EMR/EHR (Electronic Medical Record/Electronic Health Record) software should be accelerated.

While this integration is now effective with most major EHR providers in the United-States (EPIC, Cerner, Dr. Chrono, eClinicalWorks etc.), the movement is still in its infancy in the rest of the world. Sharing patient generated health data does not only enrich the database of electronic medical records or prompt doctors to adopt m-health, it also drastically cuts the costs of following patients remotely. Now, doctors can get rid of old connectivity gateways that needed monthly subscription fees. They can let patients bring their own smartphones and integrate the devices. While gateways are still needed for elderly patients in need of technical assistance, those patients that have smartphones can get better care at a lower cost. This paves the way for an extension of remote monitoring to larger sets of patients, beyond the more acute patients.

With players such as Apple and Google now offering easier ways to integrate data from patient apps to EHR apps directly on the smartphone, i.e. with GoogleFit or HealthKit, change is arriving sooner than expected.

## Training doctors

Doctors generally agree on the health benefits of new technologies. A survey carried out in 2011 by Accenture shows that over 70% of physicians in France, and nearly 60% in the United States, believe these technologies improve access to quality data for clinical research, allow better coordination of treatments and reduce medical errors. However, a generation gap has been observed, as physicians over the age of 50 remain more skeptical.

**New digital technologies are better perceived after a practice and appropriation stage. Based on this information, it is essential to train doctors on how to use new technologies.** It should be the role of medical schools to raise awareness among the medical community, taking into account the generational gap to tailor its teaching programs. This requires focusing on both the continuous training of doctors, with the introduction of new courses on m-health and connected devices, and the initial education of medical students with a curriculum comprising dedicated courses on these subjects.

### Training patients

Medical relevance of data coming from connected devices may vary depending on the circumstances of usage of these devices. **In this context, it is also important that users be trained to follow a protocol of usage.** Doctors should be able to set up an ergonomic evaluation of devices (sensors and applications) depending on each relevant target class of users. This approach, already used in pharmacology and therapeutic education, must be extended to connected health.

## 2. Reassure about devices, reassure about data

### Certifying medical devices

In some situations, the usage of connected devices has strong medical implications. It is the case for cardiac arrhythmia detectors, pulse oximeters that serve to monitor respiratory failure, or glucometers that calculate insulin doses for diabetics. In these cases, technical flaws or shortcomings are likely to result in potentially serious diagnostic or therapeutic errors. **In order to protect consumers, devices with a medical use must be certified before being introduced on the market**, such as the Nokia blood pressure monitor, a medical device approved by the FDA in the United States and holding the CE label in Europe.

More generally, **the certification of m-health applications constitutes a challenge for health authorities.** The dynamism of application publishers points to an increasingly larger number of applications being launched. How should the algorithms associated with the software be certified? When this software supports a medical prescription or decision, its evaluation would not only be complex but also need to be updated on a regular basis as new versions are released and scientific knowledge develops. One could imagine an approach of regular surveillance after introduction on the market, similar to that in place today for prescription drugs. International standardisation work on health software is underway to address the life cycle of application software used in healthcare [(17)].

If rigorous certification is needed in cases of high-risk medical use, it becomes less relevant for connected devices used in a non-medical context, such as for well-ness or fitness purposes. However, the line between these two classes is not always clear. For example, should the use of a heart rate monitor by a patient who has recently suffered from a myocardial infarction be supervised? EHR or PHR service providers that connect to personal health devices may also require some kind of certification for devices used.

For example, the Finnish national PHR project which connects consumer health devices requires some certification of devices or applications. This is part of the trend by authorities and stakeholders to clarify and accelerate m-health adoption.
In this way doctors and consumers institute trust and confidence in the ecosystem.

## Reassuring people about the safety and the confidentiality of data

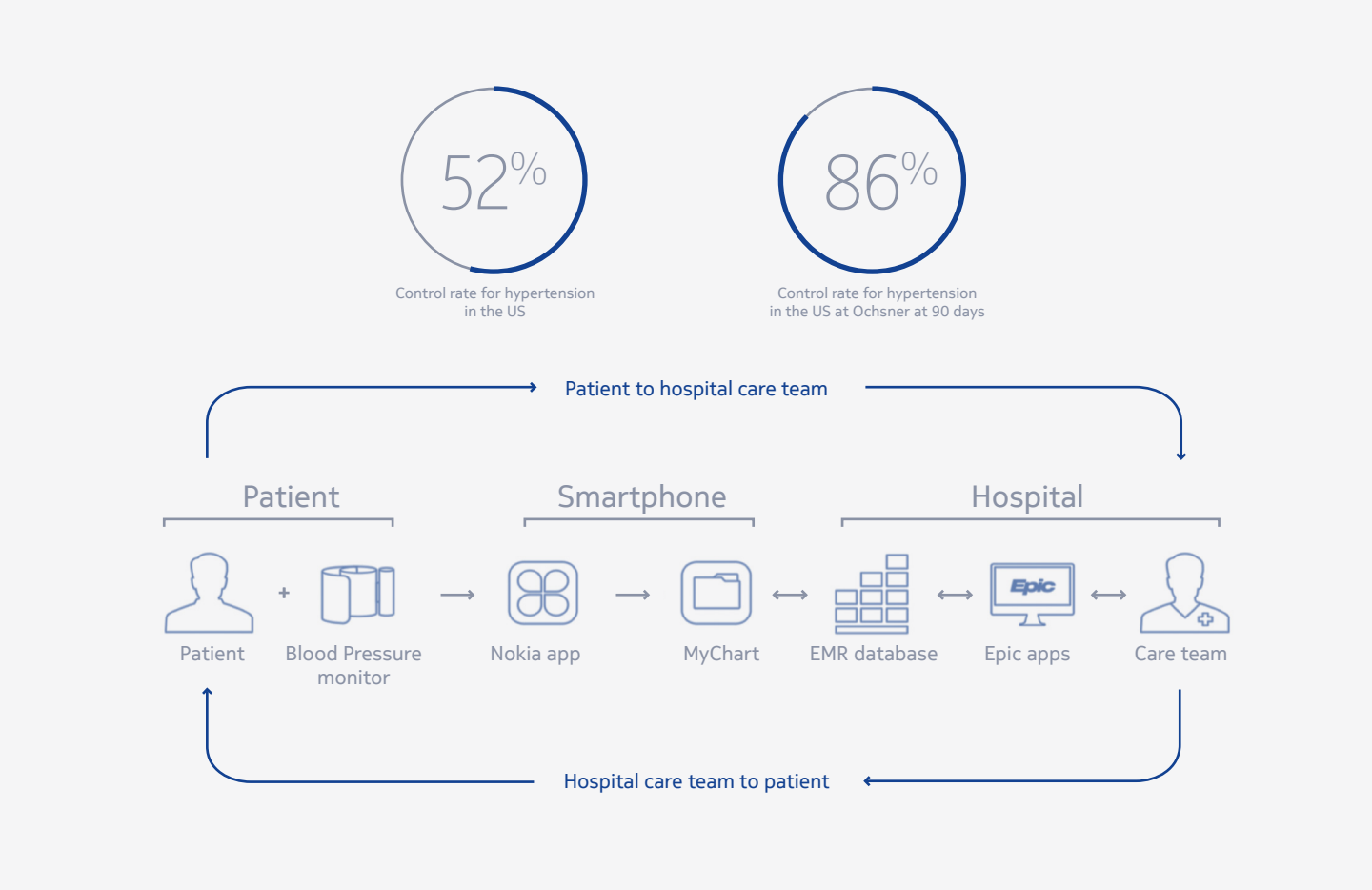
Connected devices collect personal data, which in a medical context of usage can become sensitive data. That is why it is essential to reassure users and physicians about the security of their data.

There are international, regional and national efforts to provide a certification framework or self-assessment to enable the use of Patient Generated Health Data (PGHD) by medical professionals. Initiatives such as the European m-Health Application Guidelines[(18)], HL7 International Consumer Health Application Framework[(19)] and recent draft policy framework on PGHD by US Government[(20)].

The status of data changes depending on whether the device is used for recreational purposes, in which case it's personal data, or in a medical context, in which case it **requires conformity to specific hospital norms.** The relevance of the collected data is not the same depending on whether the individual uses it himself or not.
In the first case, it is the patient's own responsibility. When a doctor uses data, he is held responsible for it and for the diagnosis he generates based on it. In this case, **an accredited hosting of health data becomes necessary.**

## Example of Nokia API being used in a remote care setting

### Ochsner Health System, example of patient engagement outside the Hospital




## Streamlining Standards and interoperability

Standards organizations across the globe are actively addressing the need for a standardised approach in certain areas of connected healthcare. There are many international standards already underway for example in IEC, HL7 and many others. The lack of formal standards is currently not a barrier to connected health uptake. It is expected that market dynamics will drive standards adoption. There is a role for government to promote conformity of standards use and market adoption of existing standards and guidelines.

In the area of product safety and minimum performance, many existing standards are in place and are covered under existing legislation. There are potentially some needs for standards around data exchange and semantic interoperability, as previously mentioned.

There is significant interest and activity around the Fast Healthcare Interoperability Resources specification (FHIR), being developed under Health Level Seven International standards organisation (HL7). FHIR is a standard which is moving quickly to apply existing and defined web technologies for exchanging information electronically in healthcare.

The exchange of data between systems and platforms through published Application Protocol Interfaces (API's) is an essential part of modern interoperability. Stakeholders in connected health organizations should be encouraged to openly publish information on how to use their API's. This opens up data flows and enables faster innovation and new applications to be tried and iterated dynamically. As stakeholders experiment with business models and solutions, the free flow of data and the exchange of data between systems and platforms, enables collaborations and acts as a catalyst. Unlocking network effects and innovation, positively creates, enables and drives connected health ecosystems.

Governments can play a role in promoting interoperability and removing barriers to data flows across borders. In this context, governments and regulators in consultation with a range of stakeholders can help set the environment and the market forces to accelerate the pace.

**For example** in the United States, two separate interoperability initiatives (Argonaut project and SMART on FHIR), are collaborations between the government and industry stakeholders to increase market dynamics, unleash innovation and ensure increase in quality care for patients. These collaborations are beginning to show success in adoption across the healthcare industry, leading to a new era of delivery of care. The Nordic region countries (Sweden, Norway, Denmark, and Finland)

have introduced national eHealth infrastructure which includes integration EHRs and patients access. Further initiative by some of these countries to integrate these EHRs with new PHRs to speed up connected health adoption is in progress.

## Clarifying Regulations

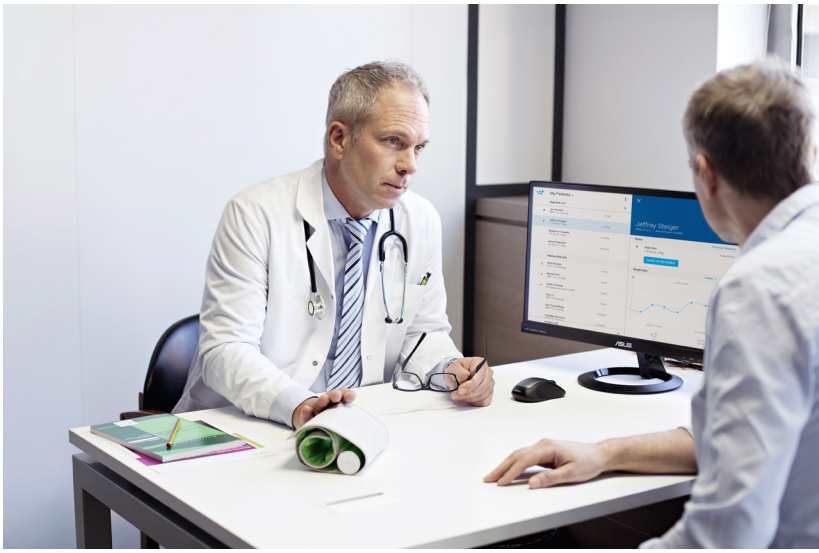
In today's market, the regulatory framework provides for regulated and unregulated health devices. It's important to keep clear differentiation in order to enable new innovative solutions to iterate and flourish. Care should be taken not to create confusion and make a third type of device or solution.

There are currently efforts to clarify the difference between medical and non-medical context (especially for the consumer health market), when it comes to health data generated by consumers' own health devices and the point of integration to EHR system. For example in the US, the Health and Human Services Department (HHS) recently issued a report to Congress on oversight of privacy and security of non-HIPPAA regulated entities, while the Office of the National Coordinator for Health Information Technology (ONC) released a new draft white paper on PGHD policy framework and Model Privacy Notice. Similarly in Europe, there is discussion on m-guidelines to safe guard among other things privacy and security on non-regulated consumer health market. The recent European Commission consultation on Smart Wearables.

It is important that no stakeholder is left out in this discussion, as policy decisions need to equally address the sensitivity of markets as well as connecting healthcare providers and patients/consumers to a thriving heath ecosystem.

Any discussion on regulation and guidelines around m-health should not conflict with regulation and certification norms already in place. Any guidelines should be light touch covering, well defined essential requirements focusing on areas such as interoperability. For example, voluntary guidelines around m-Health is a good approach.

**“In some situations, the usage of connected devices has strong medical implications.”**



# 3. Adapt the financial and regulatory framework

## Large-scale deployment

Despite the rising number of studies showing the positive impact of connected devices and solutions, the regulatory context and the health insurance organization are today an obstacle to their wide-scale adoption. The main challenges involve reimbursing patients for the devices and rethinking the way doctors are paid. In the absence of large-scale experimentation and national pilot programs, experiments are rolled out locally, relying on regional funding.

There is a gradual effort and subsequent progress by governments and payers on re-thinking reimbursement in the context of m-health or Remote Patient Care. For example, in the US, the Centers for Medicare and Medicaid Services (CMS) have started reimbursing doctors for providing remote patient care for chronic disease management.[21] In the UK, the National Health Service is introducing a new m-health reimbursement program to boost innovation and patient engagement.[22]

## Rethinking the funding of prevention and of m-health

As connected devices open the door to a new model of prevention, the question of healthcare funding arises. **If today a disease treatment is reimbursed, why not imagine funding good health itself in the future?** In less provocative terms, is it possible to imagine funding something that keeps people from getting sick? Today, billing for medical care does not sufficiently encourage early detection and home monitoring. To change that, it is necessary to study models where novel funding methods are used:

- With the rising incidence of chronic diseases, new compensation systems should optimize patients care depending on priorities. Financial compensation for doctors, based on new models of connected care are being studied and developed in many counties. Nevertheless some attempts or efforts are being made but this is only the beginning.

For example, in the US, the government has introduced Value-Based Care and Accountable Care Organization Models as part of the effort to increase quality care and reduce costs.

- **Similarly, hospitals should promote tele-care of post-surgery patients,** to shorten hospital stays and avoid readmissions.
- Lastly, sick patients and healthy people alike lack incentives to adopt prevention tools. A sedentary lifestyle, smoking habits and lack of exercise increase the odds of cancer and cardiovascular diseases. **In this context, a system rewarding healthy behaviors could be imagined.**

For example, some life and health insurers are already introducing new plans to link policyholders who track their exercise, with cash rewards and or insurance premium discounts. In the US, examples include John Hancock, UnitedHealth Care Group, Aetna, Oscar Health Insurance, Kaiser Foundation. In Australia, the Australian Life Insurance Company (MLC Ltd). While in South Africa, the South Africa Health Insurance (Discovery Health) is also piloting this concept.

## The corporate world: a new payer for healthcare?

**The real potential for prevention may lie in the workplace.** Businesses in England, Switzerland and the United States have already adopted a "corporate wellness" approach that may lead the way, where **companies fund prevention programs around the usage of connected devices.** Workplace wellness not only has an impact on productivity or absenteeism; it also ensures good health conditions on a long-term basis.

# Conclusion

## Why the digital health revolution is finally happening

Not all innovation in healthcare is destined to go through a seemingly endless succession of pilots. Vaccination campaigns, Electronic Health Records, Health Screenings are only but a few high tech or low tech innovations that have scaled. What do these successful innovations have in common? Innovation is not simply about successfully introducing new technologies. It is just as much about transforming organizations and cultures, creating new ways to tackle old problems without alienating stakeholders that stand to lose from the disappearance of previous practices. This is why scaling in digital health is so difficult. It requires a collective effort to reinvent governance, define new standards and introduce new incentives. The top down approach would lead nowhere if patients themselves were not supportive of a change that empowers them.

The big question connected health proponents have asked themselves for the last 30 years, “Is it going to scale now?” is finally being answered by a mix of technological breakthroughs, disruption with new models emerging and patient empowerement. A formidable promise is aligning expectations and forcing change, as we begin to see the focus of healthcare change from fee for services to fee for outcomes.

The purpose of this White Paper was to illustrate and detail the changes that arise with m-health in general and connected devices in particular. In this new paradigm, there is an increasing interest in healthy individuals, not with the purpose of simply treating or curing them, but especially of helping them to manage their health better

and prevent diseases from occurring, supported by cost effective remote monitoring. Since Antiquity, medicine has been divided into two roles: Hygieia (prevention) and Panacea (treatment). M-health is reconciling both. Prevention and early detection have now been given new tools to reshape medical practices. For the healthy, connected health must now live up to its promise of lowering risks of contracting non-communicable diseases. For those that are sick, connected health is slashing the cost of sharing patient generated health data (PGHD). Professionals are accessing a wealth of data and even life sciences companies can collect real world evidence to assess therapeutic efficiency of drugs. With so much new data, care professionals can identify at risk patients, and even delegate some of that analysis to Artificial Intelligence (AI).

**What patient care teams around the world are finding out now with PGHD, is that undesirable health events can be prevented and even predicted when care coordinators have right data at the right time. They can now take the right action.**

M-health and connected devices have opened the way to a second revolution – that of Big Data. Connected devices generate an unprecedented mass of data, and consequently create a new industry. In this new context, we observe a paradigm shift where the value of health data lies in its sharing and aggregation. The creation of huge databases on physical activity, weight and blood pressure of populations who voluntarily monitor themselves and agree to share their data for research or medical purposes can spur considerable medical advances. The analysis of this data will show its full potential if they can be crossed with other sources, such as social security treatment, disease databases and even genetic information.

Already, longitudinal data collected from smart scales allow care teams to predict undesirable events. For instance, patients suffering from congestive heart failure are now using smart scales to transfer weight data seamlessly to care coordinators. They can then detect who may be at risk of decompensation and intervene proactively

With new technology comes news knowledge and new responsibilities. Individuals can be treated earlier, or adopt a preventive behavior. Physicians and care coordinators

must find meaningful ways to act with that data. New data creates new accountability and new legal frameworks to allow its deployment. It raises standards for better outcomes and prediction of risks. Benefits will only be fully captured with the support from physicians, healthcare providers and public health officials. That is why this white paper has put forward a series of proposals to encourage the adoption of connected health, focusing on three main areas:

### Encourage its use by the medical profession through:

- Investing in research and experimentation;
- Educating and training doctors and other health professionals;
- Raising patients' awareness on the usage of these new tools.

### Reassuring people about connected devices and data by:

- Highlighting the protection measures that apply to personal and nominative health data;
- Certifying medical devices;
- Reassuring patients on the security and on the confidentiality of data.

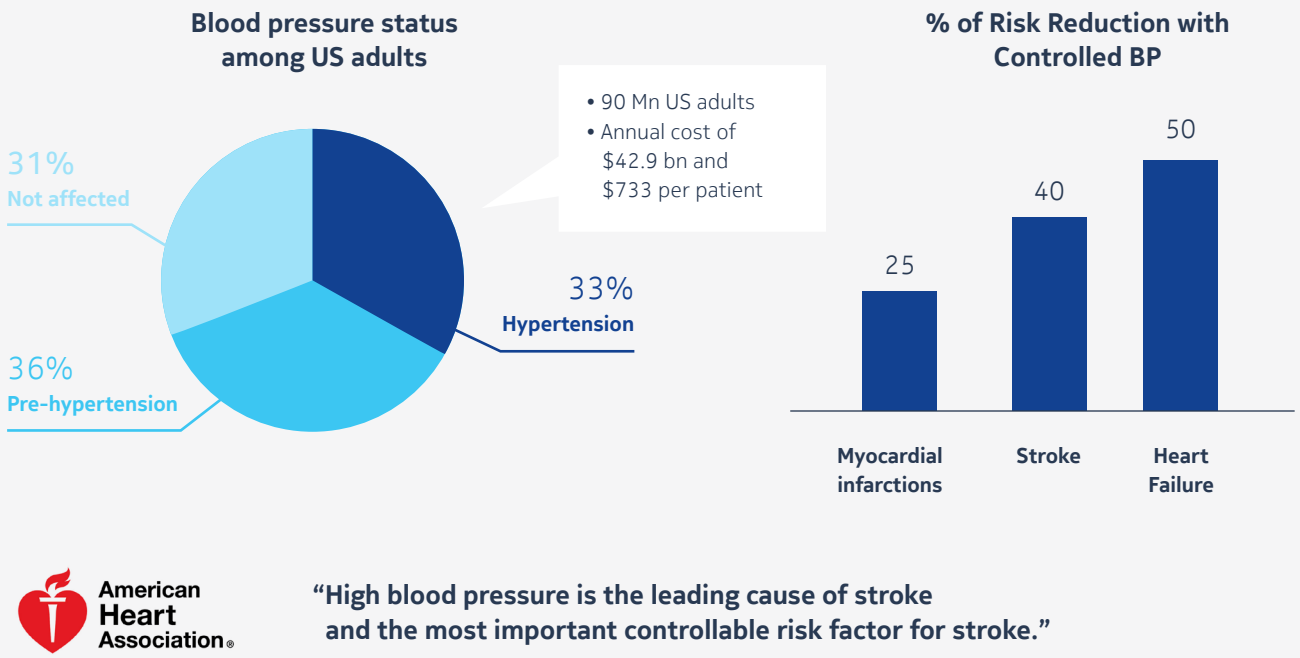
### Adapting the financial and regulatory framework by:

- Creating a high-level set up favorable to the implementation of m-health experiments;
- Rethinking the funding model for prevention and for m-health;
- Encouraging corporate wellness programs.

The above recommendations simply aim to align medical practices, expectations and regulatory frameworks on game-changing technologies, This white paper also aims to raise awareness on a healthcare revolution that is happening now and cannot be ignored by key stakeholders. The ubiquity of smartphones, the digitization of healthcare and the trend towards increasing patient empowerment alone could transform healthcare because it is providing even more data. But more data requires more intelligence. We are seeing breakthroughs in AI. These technologies will help us lead healthier lives if we collectively choose to embrace this once-in-a-lifetime healthcare disruption.

# Appendix: managing blood pressure - evidence from self-monitoring pilot study

## High blood pressure concerns a third of adults, is very costly yet easily preventable




American Heart Association®

**"High blood pressure is the leading cause of stroke and the most important controllable risk factor for stroke."**

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## Project Description

To explore solutions against this silent killer, Nokia teamed up with the American Medical Group Foundation (AMGF) to work on an 18-month project seeking to improve blood pressure control in patients with uncontrolled hypertension, in conjunction with the national Measure Up/Pressure Down® hypertension campaign. The purpose of the project was to use the Wireless Blood Pressure Monitor in a healthcare setting to understand how home blood pressure monitoring affects the patient/physician relationship; success factors in achieving blood pressure control in patients with

hypertension; enrollment, engagement, and retention of patients with the device; and modifications in physician care processes.

A total of 150 patients across 4 AMGF medical groups were included in the project: Billings Clinic in Billings, Montana; Community Physician Network in Indianapolis, Indiana; Cornerstone Health Care, P.A. in High Point, North Carolina; and Wilmington Health in Wilmington, North Carolina.

Each patient in the project was provided a Nokia Wireless Blood Pressure Monitor after being recruited as newly diagnosed with hypertension or having existing uncontrolled hypertension. A project leader at each site enrolled the patient in the project and trained him/her on using the Nokia Wireless Blood Pressure Monitor.

Patients filled out a survey pre-and-post project to record their satisfaction with using the device, improving their ability to control their blood pressure, engaging with their physician, and liking the product overall.  Physicians and project staff answered similar questions on a post-project survey.

Another component of the project included matching patients to their accompanying electronic health record (EHR) data, before and during the study, to compare with the Nokia Wireless Blood Pressure Monitor data. Only 70 patients out of 3 medical groups were included due to exclusion criteria and matching barriers.

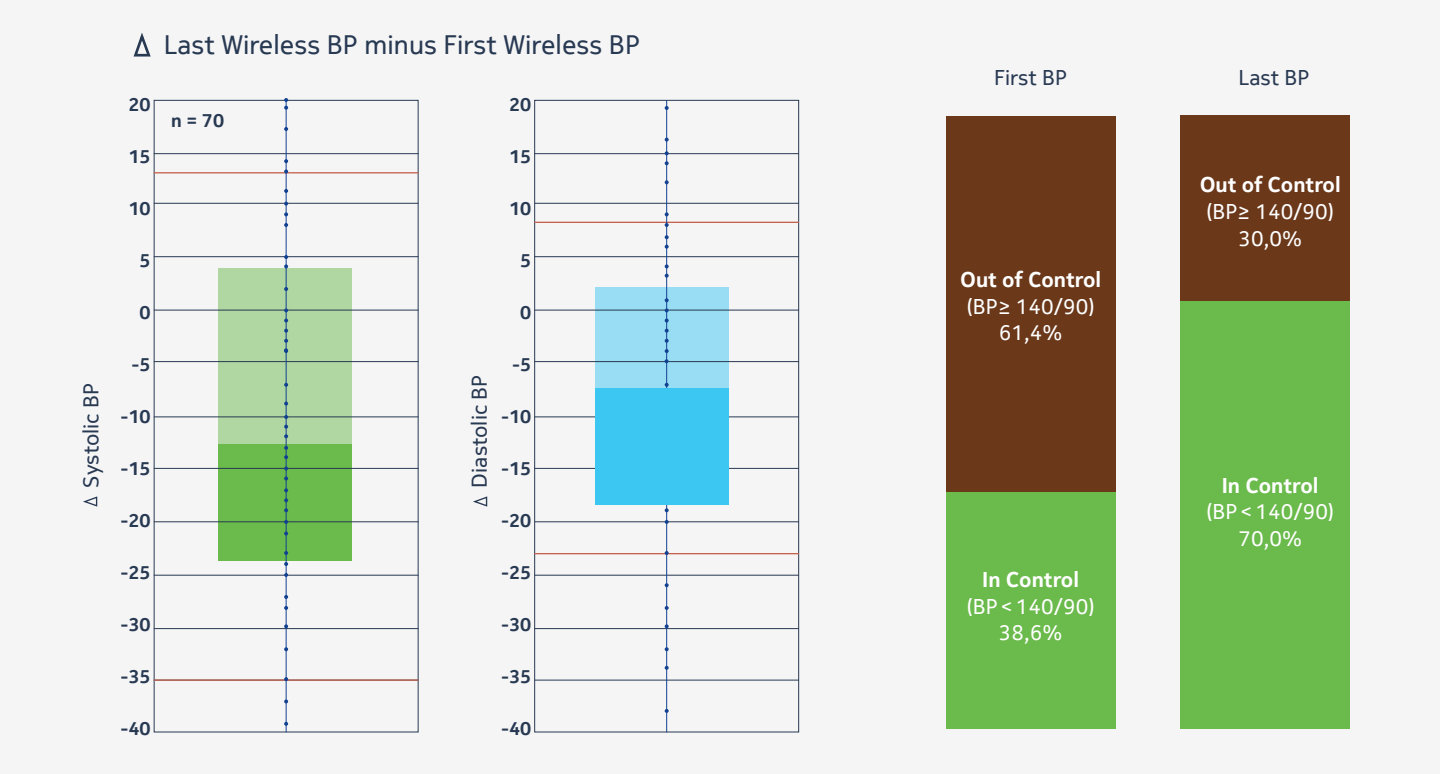
## Results

At the conclusion of the project, Patients felt that, in general, use of the device helped improve their ability to monitor and control their blood pressure, and they were able to see improvements in their blood pressure through using the device. The most striking results were found in the analysis between the EHR and portal outcomes. A change was measured between the median blood pressure recorded by the Wireless Blood Pressure Monitor (period of time was between 1 day - 9 months of the implementation phase) and the median blood pressure recorded in the office setting during the baseline period (365 days before the first Nokia measurement)

from the EHR data. **Of the 70 patients' data analyzed, blood pressure control rates improved from 44.1% to 64.7%.**

Similarly, the figure below shows a difference between the last blood pressure measurement recorded with the Nokia Wireless Blood Pressure Monitor at the end of the project and the first blood pressure measurement recorded with the Nokia Wireless Blood Pressure Monitor at the beginning of the project. Blood pressure control rates went from 38.6% to 70.0%. In other words, roughly 60% of patients were considered to have blood pressure out of control before the project as compared with 30% of patients at the conclusion of the project.

## Improvement in Blood Pressure



## Conclusion

Overall, medical groups expressed confidence in blood pressure improvements for many of their patients throughout the course of the project. The providers were happy, in general, with how useful the Wireless Blood Pressure Monitor was to help patients control their blood pressure. In general, patients believed that the device gave clear feedback on their blood pressure levels, they would recommend the device to people who are trying to monitor their blood pressure, and the blood pressure results obtained by the device were clear to them. High expectations about the Nokia Wireless Blood Pressure Monitor were formed early on in the project during recruitment and enrollment and remained high throughout.

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